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The Relationship Between the Urban Small Schools Movement and Access to Physics Education

Although the positive and negative aspects of small schools have been well documented in some respects, this study examines one issue that has been missing from the debate, namely, the relationship between school size and physics access.

Introduction

New York City is presently undergoing a fundamental shift in secondary school organization that may have long-term ramifications for academic proficiency and college preparedness. One of the key indicators of this relationship may be access to high school physics. The relatively new *Small Schools Initiative*, a centerpiece of the New York City Department of Education's (NYCDoE) school reform efforts, began as a replacement strategy for large, failing high schools. This policy reform intended to address poor educational outcomes in historically underserved communities. Since 2002, approximately 290 new small secondary schools have opened, either alone in buildings or sharing buildings with other public schools. The Chancellor of Schools has indicated that he hopes to have 25% of the city's 350,000 high school students enrolled in small schools in the future (Greene & Symonds, 2006).

The movement has met with some success. The NYCDoE recently announced that the graduation rate in 2007 for the new small schools had exceeded 70% for the second consecutive year, compared with the citywide graduation rate of 59% (NYCDoE, 2008a). Notably, more than two-thirds of students in these graduating classes entered their new schools performing below grade-level, and more than 90% were underrepresented minority students. Many of these schools have replaced those where the collective graduation rate in 2002 was 35% (NYCDoE, 2008b). The movement has received external funding from several philanthropic groups, such as the Gates Foundation (Bill & Melinda Gates Foundation, 2005) and the Carnegie Corporation of New York.

While much of the research on small schools has been positive, focusing on safer physical and emotional learning environments, the relationship of the movement to science education has rarely been considered. Smaller schools tend to constrict curricular offerings, which can influence student access to more advanced courses (Weingarten, 2004). The purpose of this study was to identify potential correlations between the small schools movement and student access to and enrollment in secondary physics.

Secondary school restructuring has had documented positive and negative effects.

The availability of physics courses is important for several reasons. Physics is an essential component of scientific literacy (National Research Council, 1995), and it also acts a gateway course for post-secondary study in science, medicine, and engineering (Madigan, 1997; Tyson, Lee, Borman & Hanson, 2007). Limited physics access typically results in diminished scientific proficiency and college science readiness (American College Testing [ACT], 2006; National Assessment of Educational Progress, 2005). Students who have taken physics are much more likely to attend four-year colleges

(Hoffer, 1995). Indeed, completion of a high school physics course has been shown to increase retention in postsecondary STEM study, particularly for underrepresented minorities (Tyson et al., 2007).

Research Questions

This study sought to examine physics offerings and enrollments, as well as teacher certification data, in small schools (<600 students) throughout New York City during the 2004-2005 academic year; results were compared to those for mid-sized (600-1200 students) and large (>1200 students) high schools. The following overarching research question was considered: What is the relationship between school size and access to physics study, an established indicator of college preparedness?

In addition, the study led us to examine several sub-questions: (a) How does physics course availability relate to school size when compared to other variables?; (b) Among schools that offer physics, which types of physics courses are available?; and (c) What is the proportion of physics-certified teachers, and how does this relate to school size?

These research questions were explored utilizing data from the NYCDoE, as well as survey responses obtained directly from school administrators. The analysis first considers current research on small schools, the status of physics availability in New York City's schools, and recent patterns of physics teacher quality. Next, the quantitative methodology and research design are described. Finally, results from the survey and a discussion of the potential relationship between the small schools initiative and physics education are presented.

Review Of Literature

Prior studies provide the framework for the analysis of the research questions. Secondary school restructuring has had documented positive and negative effects. Positive effects are mainly related to learning environment, student engagement, and graduation rates. The negative effects include curricular limitations, although physics has not been specifically addressed in existing research. Finally, the availability of physics has been typically lacking in urban schools, which is further compounded by a shortage of physics-certified teachers.

Arguments that Support the Establishment of Small Secondary Schools

Recently, New York City and many other urban areas have undergone a shift to smaller secondary schools. Larger high schools have often been viewed as detached, segregated institutions, which unwittingly provide unequal learning opportunities (Ilg & Massucci, 2003; Lipman, 1998). Administrative and instructional practices in such schools have tended to isolate students, who do not have much connection with teachers and staff (Darling-Hammond, Ancess & Ort, 2002).

A systemic shift to smaller high schools in New York City came with the hope of greater individual success. One obvious advantage is the opportunity for students to participate in a close community with shared goals (Lipman, 1998; Osterman, 2000). Students cannot remain anonymous and exhibit fewer behavioral problems and less frequent absenteeism (Darling-Hammond et al., 2002; Stiefel, Berne, Iatarola & Fruchter, 2000). Student advisement has been more meaningful and consistent (Shear et al., 2008), and more students have attended college (Schneider, Swanson, & Riegle-Crumb, 1998).

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Most importantly, small schools appear to have promoted effectiveness and equity, aiming to decrease the gap in opportunities for students of different socioeconomic status (Lee, Smith, & Croninger, 1996), thereby lessening its effect on student performance (Copland & Boatright, 2004; Darling-Hammond et al., 2002). In traditional high schools, students are frequently separated according to ability, which results in social stratification (Ready & Lee, 2008).

Small schools have been politically popular in New York City, mainly because most realize that large high schools are not meeting the needs of the city's students. However, this initiative is rather new—approximately 290 schools since 2002 (NYCDoE, 2008b)—so the political climate may change if these schools do not produce measurable results that prove their effectiveness (Bloomfield, 2005).

Potential Limitations of Small Schools

Despite the promise of drastic educational improvement through a shift to smaller schools, there have been several issues that suggest this promise may not be kept. These schools typically offered curricular uniformity as a means for greater

achievement (Monk & Haller, 1993). The rationale is that students adhere to a more academic course of study if there are fewer electives. Although this has resulted in increased graduation rates (Copland & Boatright, 2004; Greene & Symonds, 2006), students in smaller schools have not had as many opportunities to participate in advanced courses (Miner, 2005). Smaller schools with reduced staffs have fewer course options (Monk & Haller, 1993; Ravitch, 2005a), which are usually targeted towards mid-level students (Lee et al., 2000).

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Although Lee et al. (1996) elaborated on the harmful nature of course differentiation between schools, particularly for disadvantaged students, they focused on achievement rather than access. Gamoran (1996) pointed out that substantial between-school variation in opportunity must indirectly affect achievement. Few studies have substantiated the limitations of the small school structure (Herszenhorn, 2005; Ravitch, 2005b). However, an analysis of small schools data in NYC showed that small school students performed worse academically than those in larger high schools (Iatarola, Schwartz, Stiefel & Chellman, 2008). Bill Gates recently expressed his disappointment in the results of his small schools investment, stating that many did not improve achievement (Gates, 2009).

Another potential unintended consequence of small schools has been a lack of teacher support in implementing curricular reforms. Darling-Hammond (1997) suggested that these schools better served students by employing fewer administrators, since teachers take on many of their duties (counseling, discipline, etc.). However, this assumes that teachers have the expertise required to fulfill these roles. A traditional content supervisor, usually nonexistent in small schools, is instrumental in helping teachers develop sound pedagogical practices (Miner, 2005; Wyse, Keesler, & Schneider, 2008).

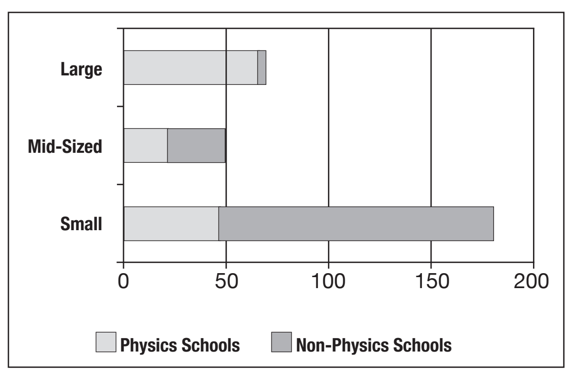
Although the positive and negative aspects of small schools have been well documented in some respects, this study examines one issue that has been missing from the debate, namely, the relationship between school size and physics access. Do small schools, which have been successful in improving graduation rates and creating a sense of community, prioritize advanced science courses? It is first necessary to examine the current status of physics in U.S. schools, and how physics access has been a particular concern for students in urban settings.

Contemporary Availability of Physics in Urban Secondary Schools

In a previously published report, the authors noted that approximately 21% of NYC high school graduates have taken physics (Kelly & Sheppard, 2008), compared with the national average of 33% for public schools (Neuschatz, McFarling, & White, 2008). The city also lagged behind the New York State's physics enrollment of 31% (New York State Education Department [NYSED], 2004). An analysis of the distribution of physics in city schools showed that access to physics was not equitably distributed—55% (164 of 298) of the surveyed New York City high schools did not offer it. This stands in stark contrast to the figures reported nationally, where physics was offered in 89% of high schools (Neuschatz et al., 2008). Additionally, race, socioeconomic status, and prior academic achievement appeared to be related to physics availability (Kelly & Sheppard, 2009).

The size of city high schools was an important factor in predicting whether or not physics was offered (see Figure 1). The vast majority (96%) of large high schools (n> 1200 students) offered physics while 45% of mid-sized schools (600<n<1200) and only 26% of the small schools (n<600) did (Kelly & Sheppard, 2008). The present study examines this trend in more detail in order to evaluate factors related to physics availability in small schools.

Figure 1: Physics availability in terms of school size in New York City, 2004-05 (n=298).



Physics Teacher Quality and Certification

The availability of qualified physics instructors has been a barrier to

Physics courses are not available in a large proportion of high schools in NYC, and this negatively affects approximately 75,000 students.

ensuring equitable opportunities in physics in urban districts (Brumberg, 2000; Hodapp, Hehn, & Hein, 2009; Ingersoll, 1999). The Council of Chief State School Officers [CCSSO] noted that teacher quality is crucial in preparing scientifically literate graduates (2007). The National Science Foundation (2008) reported that 78% of all secondary physical science teachers were certified in their respective disciplines, while CCSSO reported in 2007 that science teacher certification rates in physics had declined slightly since 1996. This may have been influenced by the rising number of secondary physics students nationwide, which reached a high of 1.1 million in 2005 (Neuschatz et al., 2008). Rapidly increasing enrollments have resulted in some states hiring less-qualified teachers to meet demand.

The academic background required to teach physics in New York State has shifted in recent years. Presently, candidates must have a bachelor's degree or 30 credits in physics, and must also pass several standardized tests (NYSED, 2009b). Prior to 2004, the minimum content requirement for physics teachers was 18 credits in physics. Consequently, all New York physics teachers should have at least a minor in physics.

The situation is, however, complicated by the practice in New York of "incidental teaching," through which school districts can allow teachers to teach one course out of their certification area. The number of teachers teaching physics through this method is unknown, though New York City has fewer qualified teachers than the rest of state (Brumberg, 2000). During the 2007-08 academic year, 16% of NYC science teachers did not have appropriate disciplinary certification; teachers who were not "highly qualified" staffed 4.8% of all biology classes, 6.0% of chemistry classes, 16.5% of Earth science classes, and 10.9% of physics classes (NYSED, 2008). According to a variety of reports the recruitment and retention of qualified physics instructors is a necessity to maintain viable secondary physics programs (The City Council of New York, 2004; Monk, 1994; Osbourne, 2003).

Methodology

As part of a larger study on physics education in New York City during the 2004-2005 academic year, information on physics enrollment and course offerings was collected using a written survey. The survey was necessary because the data could not be obtained from the NYCDoE; there was no information on physics availability and schools had to be contacted individually. Ultimately, data were collected from 298 out of the 316 schools (94%).

The information collected from the surveys included the number of physics students, the number of sections offered, the certification status of physics teachers, and the type(s) of physics courses available. Three major types of physics courses were identified:

1. *Regents Physics* is a traditional college-preparatory physics course based on the standardized New York State Physical Setting Curriculum (NYSED, 2009a). Regents Physics is normally taken by students after they have completed Regents courses in Biology (known as Living Environment), Earth Science, and Chemistry. Students are required to complete at least 1200 minutes of laboratory work before they can take the examination. Students must pass at least 5 Regents examinations in order to graduate from high school, one of which must be a science.
2. *Advanced Placement Physics* is a college-level physics course based on a College Board curriculum (College Board, 2009). This course can be either algebra-based (AP Physics B) or calculus-based (AP Physics C). The curriculum is standardized, and schools that offer the course must also complete a curricular audit to ensure compliance. A grade of 3 or better on the culminating AP Physics Exam indicates passing proficiency.
3. *Non-Regents Physics* is a thematic-based, less mathematically-oriented physics course that is often taught with the text *Active Physics* (Eisenkraft, 1998) in city schools. This course is more conceptual in nature with less challenging mathematical applications.

The survey specifically asked if physics teachers were certified in physics, as opposed to other scientific disciplines.

The dependent variable in this study was whether or not a school offered physics. Several school-level characteristics were the independent variables in the study, and data for these variables were obtained from

the Annual School Reports Cards (NYCDoE, 2006). The dependent variables included: school enrollment, graduation rate, percentage of students attending two- and four-year colleges, average SAT Math scores (a measure of mathematical proficiency), and passing rates on the biology and chemistry state standardized exams. The variables are defined in Table I. Not all of the data were available for each of the schools since some Annual School Reports were incomplete.

To answer the research questions, schools were grouped into three categories by population: large schools (>1200 students), mid-sized schools (600-1200 students), and small schools (<600 students). Similarly defined groups were used by Crocco and Thornton (2002) in their descriptive study of social studies in NYC schools, although a mid-sized range was created in this study to bridge the difference between large and small schools. Since 70% of U.S. high school students were enrolled in schools with more than 1000 students, and 50% are in schools with more than 1500 students (U.S. Department of Education, 2008), the researchers designated a mid-sized category to see if three categories could provide clearer insights. The average small school in NYC enrolled 286 students, the average mid-sized school had 816 students, and the average large school had 2892. The researchers felt that these three categories represented very different types of learning environments. Statistical analyses revealed patterns in physics course offerings, teacher certification, and school size.

Correlations between physics access and several organizational variables were examined. The differences between the variable means for physics and non-physics schools were calculated using independent-samples t-tests, based on a confidence level of 95%. Effect size was measured using Cohen's d as a benchmark for large (0.8), medium (0.5), and small (0.2) effect sizes (Cohen, 1988). A multivariate analysis of variance (MANOVA) with Bonferroni confidence intervals was performed to determine whether these predictor variables retained their significance when combined in a multivariate model (p <.001). Finally, a binary logistic regression was performed with the independent variables in order to determine how much they accounted for the variance between physics and non-physics schools. The R-squared values were computed for various combinations of the variables to identify the highest correlation with physics availability.

Table 1: Independent variables related to physics availability.

Independent Variables	How Defined
School enrollment	The total school population in grades 9-12, including special education students, both mainstreamed and self-contained. All other grades within the school were eliminated from the total.
Graduation rate	This rate is the percentage of students who began as freshman and graduated from the same school. The graduation rate for the Class of 2004 was based on students who matriculated in the school in 2000. The number included students who earned a GED or a diploma with or without a Regents endorsement.
Percentage of students attending two- and four-year colleges	This variable was a composite of the percentages of students who attended either 2-year or 4-year colleges upon graduation.
Average SAT Math score	The SAT is a standardized reasoning test developed by the College Board that has 3 sections: mathematics, verbal, and writing. This test is required by many colleges for admission.
Passing rates on New York State standardized exams in Biology and Chemistry	Science achievement was a broad indicator of the level of science performance within each school. This variable was reported by two measures: the percentage of students passing the Living Environment (Biology) Regents and Chemistry Regents examinations. The passing score was 65%.

Limitations

Several limitations relating to the research design must be acknowledged. First and foremost, physics availability and teacher certification data were self-reported, with no means of triangulating the results. Since schools have an interest in hiring highly qualified teachers in all content areas (No Child Left Behind Act, 2002), certification status figures may be inflated. By state regulation, secondary teachers in New York State must teach 80% of their classes within their area of certification, with no more than five classroom hours per week teaching in other disciplines (NYSED, 2009b), which is difficult when many of the surveyed city schools offered only one section of physics. In addition, administrators and teachers who reported enrollments may have estimated numbers of students,

resulting in some inaccuracies in the tabulations. Finally, some of the Annual School Reports did not report complete data for each school. However, this did not affect significance, and it was factored into effect size calculations.

Results

The different sized schools showed clear trends in physics enrollment distribution by course type (see Figure 2 and Table 2). Small schools had higher numbers of students enrolled in Non-Regents Physics (53%) compared to Regents Physics (47%); notably, not a single small school was able to offer Advanced Placement (AP) Physics. The great majority of physics courses offered at mid-sized schools were Regents-based (87% of all physics students), with 8% of their students taking Non-Regents and 5% taking AP courses. The types of physics courses offered at large schools had a similar distribution, with 83% of students taking Regents Physics, and more students enrolled in Non-Regents or AP (9% and 8%, respectively) than in mid-sized schools. The large school trend reflected the national trend described by the American Institute of Physics, where increased numbers of students were taking Non-Regents/Conceptual Physics and AP Physics (Neuschatz et al., 2008). The percentage of students in traditional first-year physics courses has been declining as a result.

Figure 2: Distribution of physics enrollment by physics type and school size, 2004-05.

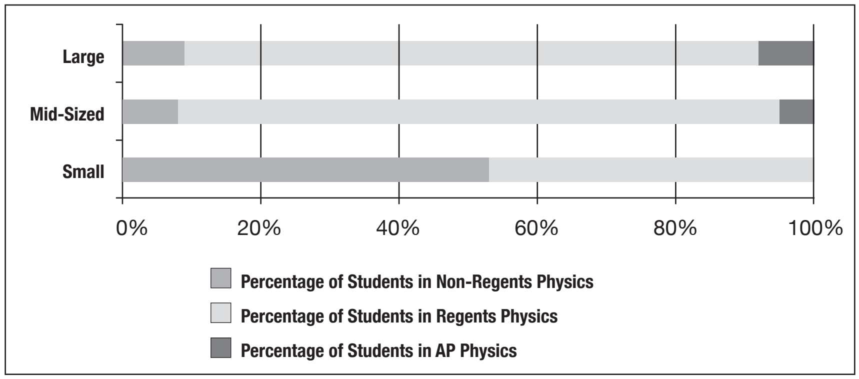


Table 2 also displays the percentage of physics students in each category of school size. Even though the majority of small schools did not offer physics at the time of the study, small schools still had a higher percentage of students taking physics (5.7%) than mid-sized (5.6%) and large schools (5.0%).

The Relative Importance of School Size in Predicting Physics Access

Independent samples t-tests were conducted to assess differences between physics and non-physics schools in the following variables (school characteristics):

- School size/enrollment
- Average SAT Math score
- Graduation rate
- Passing rates on chemistry standardized test
- Passing rates on biology standardized tests
- Percentage of college bound students

Table 3 shows that physics and non-physics schools differed significantly on all variables when considering t-values and effect sizes. Non-physics schools tended to be quite small (372 students), while physics school tended to be large (1579 students). Physics schools had higher SAT Math scores, higher graduation rates, higher passing rates on both chemistry and biology standardized tests, and higher college attendance rates. All of the tested variables had either large effect size (enrollment, SAT Math, graduation rate) or medium

Table 2: Numerical distribution of physics enrollment by physics type and school size, 2004-05.

Variable	Small Schools	Mid-Sized Schools	Large Schools
Total number of students enrolled	51,162	41,493	194,207
Number of students taking any physics course	2,937	2,303	9,695
(% of total enrollment)	(5.7%)	(5.6%)	(5.0%)
Number of students in Regents Physics	1380	2,004	8046
(% of physics students)	(47%)	(87%)	(83%)
Number of students in Non-Regents Physics	1557	184	873
(% of physics students)	(53%)	(8%)	(9%)
Number of students in AP Physics	0	115	776
(% of physics students)	(0%)	(5%)	(8%)

Table 3: Comparison of effect sizes of characteristics for physics and non-physics schools. ($p < .01$)

Variable	t	Degrees of freedom	Effect size	Mean of physics schools	Meanof non-physics schools	Mean difference	Standard error difference
Enrollment	11.3	296	1.32 (large)	1579	372	1207	112.3
SAT Math	5.9	160	0.93 (large)	449	389	60	10.3
Graduation rate	5.7	175	0.86 (large)	64%	47%	17%	3.0
Percentage passing chemistry standardized tests	4.4	140	0.74 (medium)	49%	27%	22%	4.9
Percentage passing biology standardized tests	4.2	198	0.60 (medium)	57%	40%	17%	3.9
Percentage of students college-bound	3.6	164	0.56 (medium)	74%	59%	15%	4.1

effect size (percentage passing Living Environment and Chemistry Exams, percentage attending college). According to effect size, enrollment had the greatest correlation with physics availability.

The variables that describe academic performance were also examined by school size to see if there were a difference in the means. As reported in Table 4, students in small schools had the lowest mean SAT Math scores (410) when compared to mid-sized (419) and large (454) urban high schools. Their passing rates on Chemistry (35%) and Living Environment (46%) Regents Exams were lower than those for large schools (44% and 53%, respectively), but slightly higher than mid-sized schools (30% and 45%). The graduation (58%) and college attendance (67%) rates for students in small and mid-sized schools (57% and 66%, respectively) were approximately the same, but the graduation rate for large schools was slightly higher (60%) and the percentage of college-bound students was slightly lower for large schools (64%).

Once the significance and effect size of the individual variables were determined, a multivariate analysis of variance (MANOVA) was performed using Bonferroni confidence intervals. The joint multivariate Bonferroni approach sets up 95% confidence intervals around the parameter coefficients. All of the previously tested individual variables remained significant (Wilk's1= .651, $p < .001$) in the multivariate model, as indicated by the confidence intervals in Table 5.

Finally, the six numerical independent variables were analyzed using binary logistic regression, in order to determine to what extent they accounted for the variance between physics and non-physics schools. When combined into one equation, the six variables had an R-squared value of 0.614 ($p < .01$), indicating that they accounted for 61.4% of the variance between the two types of schools. Through backward stepwise regression, it was apparent that

Table 4: Comparison of means for enrollment and academic performance among small, mid-sized, and large high schools.

Variable	Small Schools	Mid-Sized Schools	Large Schools
Enrollment	286	816	2892
SAT Math	410	419	454
Graduation rate	58%	57%	60%
Percentage passing chemistry standardized tests	35%	30%	44%
Percentage passing biology standardized tests	46%	45%	53%
Percentage of students college-bound	67%	66%	64%

Table 5: Analysis of variance of independent variables using Bonferroni confidence intervals.

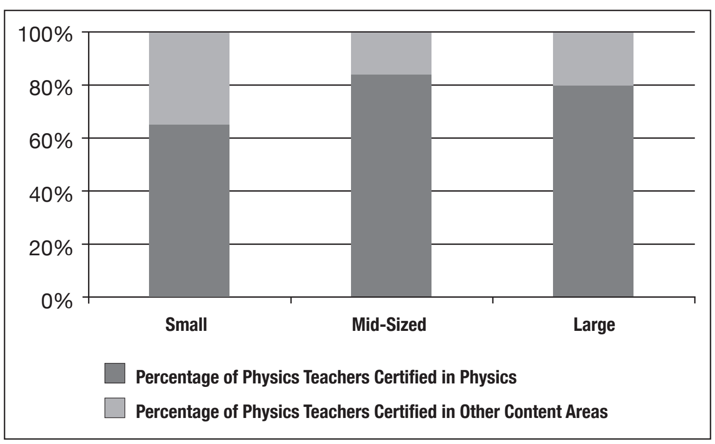
Variable	t	Standard error	95% confidence interval of the difference	
			lower	upper
Enrollment	5.0	280	639	2177
SAT Math	4.2	14.6	21.7	102
Graduation rate	3.7	4.23	4.12	27.3
Percentage passing chemistry standardized tests	3.9	5.92	6.64	30.0
Percentage passing biology standardized tests	3.8	5.49	5.94	36.0
Percentage of students college-bound	3.1	5.48	2.16	32.2

biology and chemistry standardized test scores and college attendance rate did not contribute significantly to the model, as expected when considering effect size. After eliminating these variables, enrollment, SAT Math scores, and graduation rate accounted for 51.1% of the variance (R-squared = 0.511). The model was further analyzed by examining various iterations of independent variables to predict physics availability, and each time school enrollment was the most significant predictor, followed by SAT Math scores and graduation rate. For example, enrollment and graduation rate predicted 49.7% of the variance, enrollment and SAT Math scores predicted 48.4%, and graduation rate and SAT Math scores predicted 31.5%. This again indicates that school size is the single largest correlating factor when considering whether or not physics was offered.

Physics-Certified Teachers in Small Schools

The distribution of physics-certified teachers was also examined in the context of school size (Figure 3). A total of 114 physics teachers in 91 schools responded to the survey question regarding certification. Large and mid-sized schools had an advantage over small schools in terms of the percentage of physics teachers who were certified in the field: 80% of physics teachers in large schools and 84% of teachers in mid-sized schools were certified in physics, while just 65% of physics teachers in small schools were certified in the subject. The sample size is smaller than that of the overall study because administrators often did not report the certification status of their physics teachers in the survey response.

Figure 3: Location of physics-certified teachers by school size (n=91 schools), 2004-05.



Discussion

A basic understanding of physics is critically important for comprehending contemporary scientific and technological issues. It is problematic that 79% of city students graduate high school without having taken a physics course. Physics courses are not available in a large proportion of high schools in NYC, and this negatively affects approximately 75,000 students. The availability and organization of the sciences in small schools needs to be reconsidered if future generations of students are not to be disenfranchised by restricted physics access.

That so few small schools offer physics (only 26%) is a troubling trend, because the city plans on increasing the number of small schools, particularly in high poverty areas such as the Bronx. Although small schools have improved school climate and student retention, the question of access to advanced science needs to be answered. Limited physics opportunities are detrimental for students who wish to pursue post-secondary science (ACT, 2006; Tyson et al., 2007). If New York City continues to open more small schools, the number of students who have graduated after taking physics may actually decrease.

A positive note regarding physics in the small schools is that a higher percentage of the overall small school population (5.7%) was enrolled in physics than mid-sized (5.6%) and large schools (5.0%). This suggests that when small schools do offer physics, the curricular uniformity results in a larger proportion of students taking physics than in a typical large high

school, where many students can elect not to take it. This is an encouraging trend, yet the opportunity needs to be expanded to the other 74% of small schools that do not offer physics. If this were the case, small schools could be instrumental in boosting physics enrollment and preparing more students for advanced STEM study.

When examining academic variables related to physics availability, there are some noticeable differences between physics and non-physics schools, and among schools of different sizes. Physics schools typically reported higher SAT Math scores, passing rates on standardized science tests, and higher graduation and college attendance rates. Small schools reported lower SAT Math than mid-sized and large schools, and considerably lower science scores than large high schools. This suggests that prior science and math achievement may negatively impact whether or not schools choose to offer physics. Although small schools have the highest college attendance rates of the three school types, their students seem to perform at a lower level than those in larger schools. Further research is needed to understand how small schools might leverage improved student retention to boost achievement.

School size also appears to be a factor in the types of physics courses offered. Physics courses offered in large NYC high schools mirrored the national trend (Neuschatz et al., 2008) in that some students enrolled in Conceptual and Advanced Placement Physics, while the majority enrolled in Regents Physics. However, slightly more than half of small schools offered Non-Regents Physics, and the rest offered Regents Physics. This suggests two key points for consideration. First, the small school structure seems particularly conducive to teaching Non-Regents Physics. This conceptual course, which is less mathematical in nature than a standard college-prep physics course, is well suited to a heterogeneous population with varying science backgrounds. It can be taught to younger students with relative ease. Since small schools have more course uniformity, such courses are desirable. However, the question remains whether students are adequately prepared for college physics after a single Conceptual Physics course; ideally, this course could be the first of a 2-course physics sequence. Secondly, AP Physics was only available in 20 of 298 (6.7%) schools, all with more than 800 students. A larger student population seems necessary to support study of advanced college-level physics. However, small schools could look at ways of offering higher-level physics, such as combining interested students from different schools within the same building or neighborhood, or partnering with nearby colleges.

Physics appears to be a barometer of equity when considering science course taking opportunities.

The number of physics teachers certified in physics appears to vary with school size. In small schools, only two-thirds of physics teachers held physics licenses, less than large (80%) and mid-sized (84%) schools. Science teachers in small schools often have to teach outside of their certification because there are fewer faculty. Further research is needed to determine the impact of certification status on student learning in physics classrooms.

Implications

The political leadership in New York City enthusiastically supports the expansion of the small schools initiative to improve graduation rates and other academic outcomes. However, the limited availability of physics in such schools is a curricular restraint that warrants careful consideration. The successful completion of a high school physics course provides an advantage for students who plan to attend college, particularly those who wish to study STEM-related disciplines Students are more likely to persist if they have taken a physics course. The causes for this relationship are beyond the scope of this study. However, physics appears to be a barometer of equity when considering science course taking opportunities. It is a source of educational capital, in that it provides authenticity and status, and it is often a requirement for admission to competitive colleges. Since smaller schools seem to have considerable difficulty in offering physics, further expansion should be contingent upon realistic policy proposals that aim to equalize access to it.

The question of physics availability is part of the larger issue of transparency. Although there have been some studies related to the academic performance of small school graduates, few have examined students' achievement in terms of opportunity-to-learn considerations. There are fewer advanced courses, but what does this mean in terms of student outcomes? The investment of capital in the small schools initiative necessitates accountability structures that ensure students are receiving more than just

an adequate education (Rebell & Wolff, 2008). Reliable data on course availability should identify potential curricular shortfalls and propose solutions for improvement. Smallness alone does not guarantee excellence; schools must hold themselves accountable to rigorous academic standards (Copland & Boatright, 2004; Iartarola et al., 2008). These standards should be communicated to parents and students so that opportunities are clearly understood before students enroll.

Examining course offerings and teacher certification are two ways to analyze how well these schools are meeting the needs of their students. Small schools are retaining students, a positive outcome, but their effectiveness in terms of availability of advanced courses and highly qualified teachers (and, by extension, achievement) needs further examination. As with most academic innovations, educators must find ways to maintain the advantages while minimizing harmful consequences. With the development of creative solutions to improve access to, and success in, advanced science, small schools have tremendous potential to enhance educational opportunities for urban children.

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